SUBSURFACE GEOTECHNICAL ASSESSMENT

Exploratory Soils Investigation
200 Acre Proposed Subdivision Site
Princeton, Minnesota

Project No. 2003.127

PREPARED BY
DEVELOPMENT ENGINEERING, PA
1296 HUDSON ROAD
ST PAUL, MN 55106

September 8, 2003

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OBJECTIVES AND SCOPE OF SERVICES

Development Engineering, PA, 1296 Hudson Rd, St Paul, Minnesota, 55106 was retained by Solid Ground Development, LLC, herein after referred to as the "Client", to perform a subsurface geotechnical assessment on a parcel of land located at the address in the above title block. The purpose of this investigation is to identify and evaluate soil properties on the site with respect to constructing a proposed Subdivision, thereon.

On August 28, 29 and September 3, 2003, fifteen soil borings were performed to nominal depth of 20± feet within the project area at locations directed by the client. From the resulting data, conclusions are drawn regarding site suitability for the proposed use and recommendations are presented regarding general site suitability, foundation design, floor slab design and pavement design.

SCOPE OF SERVICES

The client authorized the following scope of services:

Perform fifteen (15) standard penetration test boring to nominal depths of 20± feet below grade.

Sample soil using a 2" O.D. split-barrel sampler driven into the soil by a 140 lb weight falling 30". After an initial set of 6", the number of blows required to drive the sampler an additional 12" is known as the penetration resistance or N-value. The N-value is an index of the internal friction of cohesionless soil, the consistency of cohesive soils, and the density of all soils. Sampling will conform to the methods set forth in ASTM procedure D1586-84.

Classify recovered soil samples by the Visual-Manual method in accordance with ASTM D-2488. Representative portions of the samples may be submitted to the laboratory for further examination and for verification of the field classification in accordance with ASTM D2487-85. Information indicating depth and identification of the various strata, the N-value, water level information and pertinent information regarding the drilling method will be documented on comprehensive soil boring logs.

Prepare an engineering report including a log of each boring along with our recommendations for allowable soil bearing pressures and estimates of foundation settlement.

The purpose of this report is to present the results of our field and laboratory exploration assessment and the associated engineering review. Please note that this report is for geotechnical purposes only and is not intended to document the presence or absence of any environmental contaminants that could be present at the site.

SITE OBSERVATIONS

The property is an existing farmstead.

BORING LOCATIONS AND ELEVATION

The number of borings and their locations were determined by the Client and staked in the field. Boring locations with elevations are shown on the enclosed Site Drawing prepared by Land Surveyor, E.G. Rud & Sons.

FIELD INVESTIGATION

The borings were accomplished using the Standard Penetration Test (SPT) method of investigation using a Split-Barrel Sampler (SBS). An attachment describes the soil classification system used (Unified).

SOIL BORING RESULTS

Refer to the individual boring logs for a detailed description of soils and moisture conditions encountered. Attached to the soil boring logs is a key explaining terms and entries. The depth of individual layers of soils may vary somewhat from those indicated on the logs due to unsampled intervals between split-barrel sampler tests and, most importantly, the occurrence of transition between soil layers. Also, soil profiles not in the vicinity of the borings may vary. Refusal to auger advancement was not encountered at the boring locations, indicating lack of bedrock to depths tested.

Groundwater was encountered in all of the bore holes. The water level checks were performed at the completion of the boring and at varying times after the boring. The recordings are depicted in the boring logs. Groundwater levels may occur and vary according to various climatological and meteorological influences undetermined within the tie frame, scope and budget allowed in this investigation. In addition, area development patterns can influence groundwater. The indicated groundwater results are for conditions at the time of testing only.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based upon interpreted results of boring logs. Because the borings represent a small portion of the site in relation to the proposed area of work, ongoing review of construction should be carried out. If excavations reveal subsurface soils of a different nature than those observed in the boring, the Geotechnical Engineer should be contracted for possibly revised recommendations (see the following sections below; 6. Inspections and Testing and 10. Limitations of Investigation).

1. General Site Suitability

No specific loading information was given to Development Engineering at the time of this report.

A Conceptual Plan showing proposed lots and roads layouts where given to the Geotechnical Engineer at the time of this Subsurface Geotechnical Assessment. The Conceptual Plan did not have any proposed grades.

For an ordinary cut and fill approach to site correction, the proposed building pad areas and roads, oversized as necessary, should be cleared of all uncontrolled fill, organic, loose, frozen or otherwise unsuitable soil, vegetation, debris and boulders (3"+) prior to structure or fill placement. All excavated organic material, uncontrolled fill, wet unstable soil or other soil contaminated with topsoil, vegetation, etc, should be disposed of offsite, or in landscaping areas, where the bearing of weight will not be required.

Table 1 Analysis of Soil Borings

Boring Number	Surface Elevation	Estimated Depths of Excavation (feet)	Allowable Bearing Capacity (psf) at bottom of Excavation	Elevation of Groundwater (feet)*	Estimated Elevations of Bottoms of Excavations (feet)
1	982.17	2.5±	2000	977.67±	979.67
2	980.89	5.0±	2000	977.49±	975.89
3	988.66	1.0±	2000	981.86±	987.66
4	982.43	2.5±	2000	979.23±	979.93
5	984.44	7.5±	2000	979.84±	976.94
6	988.42	0.5±	2000	981.22±	987.92
7	988.50	2.0±	2000	981.80±	986.50
8	986.81	1.0±	2000	980.71±	985.81
9	987.02	1.0±	2000	981.22±	986.02
10	982.12	2.0±	2000	975.82±	980.12
11	979.83	2.5±	2000	976.33±	977.33
12	980.98	2.5±	2000	976.78±	978.48
13	980.56	2.5±	2000	978.46±	978.06
14	981.88	2.5±	2000	977.88±	979.38
15	982.11	2.5±	2000	977.31±	979.61

* 1) Advisory - Lowest Building Floor Slab should be set 4 feet or more above elevation of groundwater.
2) Streets, driveways and parking lots should be set 3 feet or more above groundwater elevation.

It should again be emphasized that the depths of unsuitable soil given above are a preliminary estimate based upon random split-barrel sampling tests. A small amount of additional estimated excavation depth should be added to that given in the logs and Table 1, Analysis of Soil Borings, to conservatively allow for variations in the soil profile and for inadvertent over excavations, which are impossible to avoid, when using power machinery.

2. Foundation Design and Assumptions

For purposes of proposed construction, foundations and fill to support foundations must rest upon and over mineral (non-organic) soils of adequate bearing value. For a light building such as a single family residence with standard footing size, a target allowable bearing capacity of 2000 pounds per square foot (psf) is usually assumed.

If the site is prepared as outlined in Table 1, removing unsuitable soil and placing controlled oversized fill as necessary, then strip or pad footings may be designed as indicated in Table 1, Allowable Bearing Capacity. This capacity is in accordance with recommended levels of compaction of controlled fill and settlement control requirements. This should provide a factor of safety against foundation failure of approximately 3. Over-all settlement may be 1" or less, half of which would be differential.

For frost protection please refer to the local building code for minimum cover over the footing, generally 42 inches to 48 inches minimum.

The bottom of the excavations should be compacted with a large mechanical vibrating compactor, to compact over excavated soils caused by power equipment, prior to placing footings, floor slab or engineered fill.

All fill supporting the foundations should be compacted to a minimum of 95% of Standard Proctor density, oversized (see enclosed detail) and inspected with documentation. This 95% compaction requirement includes utility, floor slab and foundation trench backfill.

If site correction occurs during winter, the base of excavation should be adequately protected from freezing. Recommendations appears on the standard data sheet at the end of this report entitled "Freezing Weather Effects on Building Construction."

If any other footing arrangements or alternatives are considered, if foundation loadings are higher, or if soils of a significantly different nature are discovered during excavations, the office of Development Engineering should be contacted for re-analysis.

3. Floor Slab

The floor slab should also rest upon and over mineral soil of adequate density. This density needs only to be sufficient to control settlement potential. The floor slab will be placed upon engineered fill, compacted and tested, see Table I. The maximum floor loads will not exceed 300 psf.

The floor slab can be supported on compacted fill placed to attained grade. All fill supporting the floor slab should be compacted to a minimum of 95% of Standard Proctor density. This 95% compaction requirement includes utility and foundation trench backfill.

Floor slabs should have clearance from maximum anticipated groundwater level and should be protected from intrusion by surface waters. This groundwater clearance should be four feet or more from known groundwater level, which it is. Site grading should be controlled so that no opportunity is provided for water to enter subsoils or foundation wall backfill areas. We suggest using floor slab moisture vapor protection. Please refer to the recommendations relative to use of a granular layer and vapor membrane which appears on the standard data sheet at the end of this report entitled "Floor Slab Moisture/Vapor Protection."

Prior to pouring the floor slab the ground should be compacted using the largest compactor as practical.

If fill below floor slab levels is not compacted, or if quality control is abandoned then some premature deterioration (cracking, settlement) over time, with early loss in value anticipated.

4. Sidewalk/Exterior Building Backfill

Soils placed below exterior sidewalks should be compacted to a minimum of 95% of Standard Proctor density. Other recommendations relative to backfilling the structure and placing fill below exterior slabs appears on the standard data sheets at the end of this report. These sheets are entitled:

- Basement/Retaining Wall Backfill and Water Control
- Freezing Weather Effects on Building Construction

These sheets present information on preferred soil types, frost considerations, drainage, and lateral pressures. We recognize that basements are not planned for this building although the first data sheet also provides information on lateral earth pressures for design of exterior retaining walls.

5. Fill and Placement

Fill material, as required, should be mineral soil, free of debris, boulders and organic material, of such suitable moisture content that it can be readily compacted to specified levels. Fill should be placed and compacted in a manner that will allow completed compaction of the total fill layer to 95% of standard maximum density according to ASTM D 698.

Frozen material should not be used in fill construction, nor should any part of the completed fill be allowed to freeze.

A soil compaction test should be conducted for every two feet of fill in appropriate segments of the area.

If any engineered fill is placed under the footings, once finished grades on the proposed structures are set, the fill should extend from the footings as shown on the enclosed detail "Normal Excavation Oversize" assuming that the subsoil is the same as that indicated in the soil borings.

If any engineered fill is placed under the footings and different subsoils are encountered through the construction process (such as the excavation of the foundation or utilities, additional soil borings, or any other site work) then the Geotechnical Engineer should be contacted immediately (see 6. Inspection and Testing) and oversizing could be based as per the enclosed detail "Oversize For Swamp or Extremely Soft Conditions.

6. Inspection and Testing

The recommendations in this report are based on the subsurface conditions found at our test boring locations. Soil conditions can be expected to vary away from the soil boring locations, we recommend on-site observation by a Geotechnical Engineer or technician during construction to evaluate these potential changes. Soil density testing should be performed on new fill placed in order to document that the project specifications for compaction have been satisfied. Documentation should be provided on all house pads and roads including oversizing, depths of excavation, final pad size and elevations of the finished grades of compacted engineered fill.

7. Final Site Topography

Final soil surfaces should be graded to provide adequate drainage from structures and hard surfaces so that as little water as possible infiltrates into soils adjacent to the structures. The areas adjacent to footing walls should be adequately compacted, not loosely placed, to avoid this zone acting as a "sump" and creating nuisance conditions in the building area.

8. Pavement Subgrade Preparation

We refer to the attached sheet entitled "Bituminous Pavement Subgrade Preparation and Design" for information on pavement design and subgrade preparation including items such as test roll evaluation, subgrade drainage and compaction recommendations.

After removal of topsoil we anticipate that granular base soils should be suitable pavement subgrade material after surface compaction. After subgrade preparation, the stability of the pavement subgrade should be evaluated by means of a test roll prior to paving. New fill should be compacted per the Specified Density Method (MnDOT Specification 2105.3f1).

Parking lots and driveways should have clearance from maximum anticipated groundwater levels. This groundwater clearance, as practical, should be three feet or more from known groundwater level.

9. Pavement Section Thickness Designs

The thickness of pavement section will depend on the type of material present within the upper portion of the subgrade. It is assumed that this subgrade material will consist of the existing silt or sandy loams found on this site. In this report, we recommend the pavement design be based on an R-value of 70, AASHTO Soil Type A-3.

10. Limitations of Investigation

The Geotechnical Engineer has prepared this report using an ordinary level of care and in accordance with generally accepted foundation and soil engineering practices. Because the borings represent only a small portion of the total site and for other reasons, Development Engineering, P.A., does not warrant that the borings are necessarily representative of the entire site but only of the boring locations at the time of investigation. No warranty of the site is made or implied. The boring logs should only be used in preliminary design and estimating work and in conjunction with corrective procedures.

The scope of this report is limited strictly to geotechnical issues which include the establishment of soil profile and only those conclusions expressly made. Please note that this work is not intended to document the presence or absence of any environmental contaminants at the site, nor for identifying applicable local, state or federal laws or regulations of a on-geotechnical nature which may or may not be applicable to this site. Further, Development Engineering, P.A., will not be held responsible for facts not disclosed to the Geotechnical Engineer.

The bore hole voids were backfilled by Development Engineering using native cuttings or sealed as per the Minnesota Department of Health Rules. Some continuing settlement may occur if construction does not take place in the near future. If settlement does occur, the Client should backfill with additional material.

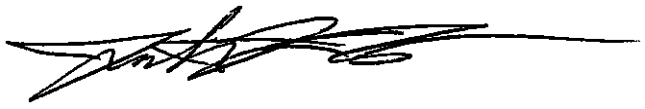
This report and all supporting information is furnished only to the Client and his assigns for the designated purpose. No representations to other parties or for other uses are made.

Soil samples retrieved during the investigation process will be retained in the office of Development Engineering for a period of 30 days from the date of testing. After 30 days from the date of testing. After 30 days, the samples may be discarded unless a request is received to retain for a longer period.

ENGINEER'S CERTIFICATE

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the Laws of the State of Minnesota.

DEVELOPMENT ENGINEERING, P.A.



Jonathan L. Faraci, PE
Minnesota Registration No. 16464

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 1

DEPTH IN FEET	SURFACE ELEVATION: 982.17 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0"-6") Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Very Loose	Glacial Outwash	2	N	1	SBS	16			
2-	(6"-20') Brown Sand, fine grained, poorly graded, (SP), Moist, Very Loose									
3-			4.5	N	2	SBS	15			
4-	Light Brown, mottled and very moist @ 2.5'	▽								
5-	Loose and wet @ 5'									
6-			6	Y	3	SBS	16			
7-										
8-			5	Y	4	SBS	15			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Clear

TEMP: 85°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
8/28/03	12:15	20'	20'	N/A	N/A	6.3'	BCR
8/28/03	12:30			4.7'	N/A	4.5'	ACR
8/28/03	12:45			4.5'	N/A	Wet	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 8/28/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 2

DEPTH IN FEET	SURFACE ELEVATION: 980.89 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0'-1') Black, Organic Sand, fine grained, poorly graded (OL-SP), Very Moist, Very Loose	Glacial Outwash	1	N	1	SBS	18			
2-	(1'-20') Grey Sand, fine grained, poorly graded, (SP), Very Moist, Very Loose									
3-		▽	2.5	N	2	SBS	16			
4-	Brown and mottled @ 2.5'									
5-	Wet @ 3.5'									
6-	Loose @ 5'		7	Y	3	SBS	15			
7-										
8-	Light Brown @ 7.5'		5	Y	4	SBS	16			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Clear

TEMP: 85°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
8/28/03	2:00	20'	20'	N/A	N/A	6.8'	BCR
8/28/03	2:15			3.4'	N/A	Wet	ACR
8/29/03	9:45			3.4'	N/A	Wet	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 8/28/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 3

DEPTH IN FEET	SURFACE ELEVATION: 988.66 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0"-7") Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Loose	Glacial Outwash	5	N	1	SBS	17			
2-	(7"-20') Brown Sand, fine grained, poorly graded, (SP), Moist, Very Loose									
3-			4	N	2	SBS	15			
4-	Light Brown @ 2.5'									
5-										
6-			4.5	N	3	SBS	14			
7-										
8-	Loose and wet @ 7.5'	▽	6	Y	4	SBS	15			
9-										
10-	Very Loose @ 10'									
11-			3	Y	5	SBS	14			
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA		WEATHER: Partly Cloudy		
21-	End of Boring @ 20'. No Refusal.							TEMP: 80°		

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
8/29/03	10:30	20'	20'	N/A	N/A	8.7'	BCR
8/29/03	10:45			6.8'	N/A	Wet	ACR
8/29/03	11:00			6.8'	N/A	Wet	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 8/29/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 4

DEPTH IN FEET	SURFACE ELEVATION: 982.43 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0'-1') Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Very Loose	Glacial Outwash	2.5	N	1	SBS	16			
2-	(1'-1.5') Dark Brown Sand, fine grained, poorly graded (SP), Mottled, Moist, Very Loose									
3-	(1.5'-20') Brown Sand, fine grained, poorly graded (SP), Wet, Very Loose		5	Y	2	SBS	13			
4-	Loose @ 2.5'									
5-										
6-			6	Y	3	SBS	14			
7-										
8-			8	Y	4	SBS	15			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Partly Cloudy

TEMP: 80°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
8/29/03	1:15	20'	20'	N/A	N/A	5.3'	BCR
8/29/03	1:30			3.3'	N/A	3.2'	ACR
8/29/03	1:45			3.3'	N/A	3.2'	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 8/29/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 5

DEPTH IN FEET	SURFACE ELEVATION: 984.44 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0'-1') Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Very Loose	Glacial Outwash	3.5	N	1	SBS	17			
2-	(1'-20') Brown Sand, fine grained, poorly graded (SP), Moist, Very Loose									
3-	Mottled @ 2.5'		2.5	N	2	SBS	15			
4-		▽								
5-	Wet @ 5'									
6-			2	Y	3	SBS	15			
7-										
8-	Medium Dense @ 7.5'		11	Y	4	SBS	16			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Cloudy

TEMP: 70°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
8/29/03	11:45	20'	20'	N/A	N/A	6.0'	BCR
8/29/03	12:00			4.6'	N/A	Wet	ACR
8/29/03	12:15			4.6'	N/A	Wet	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 8/29/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 6

DEPTH IN FEET	SURFACE ELEVATION: 988.42 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0"-1") Black, Organic Sand, fine grained, poorly graded (OL-SP), Dry, Loose	Glacial Outwash	6	N	1	SBS	18			
2-	(1"-20') Brown Sand, fine grained, poorly graded (SP), Dry, Loose									
3-	Mottled @ 2.5'		8	N	2	SBS	11			
4-										
5-	Moist and Mottled @ 5'									
6-			9	N	3	SBS	14			
7-		▽								
8-	Wet @ 7.5'		5	Y	4	SBS	13			
9-										
10-										
11-			6	Y	5	SBS	16			
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA		WEATHER: Cloudy		
21-	End of Boring @ 20'. No Refusal.							TEMP: 70°		

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
8/29/03	10:30	20'	20'	N/A	N/A	9.2'	BCR
8/29/03	10:45			7.2'	N/A	Wet	ACR
8/29/03	12:10			7.1'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 8/29/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 7

DEPTH IN FEET	SURFACE ELEVATION: 988.50 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0'-1') Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Loose	Glacial Outwash	6	N	1	SBS	15			
2-	(1'-2') Dark Brown Sand, fine grained, poorly graded (SP), Mottled, Moist, Loose									
3-	(2'-20') Brown Sand, fine grained, poorly graded (SP), Moist, Loose	▽	8	N	2	SBS	14			
4-										
5-	Light Brown and Mottled @ 5'									
6-			6	N	3	SBS	15			
7-										
8-	Wet @ 7.5'		5	Y	4	SBS	16			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Partly Cloudy

TEMP: 80°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
8/29/03	3:15	20'	20'	N/A	N/A	8.5'	BCR
8/29/03	3:30			6.7'	N/A	Wet	ACR
8/29/03	3:55			6.6'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 8/29/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 8

DEPTH IN FEET	SURFACE ELEVATION: 986.81 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0"-6") Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Loose	Glacial Outwash	6	N	1	SBS	15			
2-	(6"-20') Brown Sand, fine grained, poorly graded, (SP), Moist, Loose									
3-			6	N	2	SBS	16			
4-	Light Brown @ 2.5'									
5-	Very Moist and Mottled @ 5'									
6-		▽	7	N	3	SBS	14			
7-										
8-	Wet and Very Loose @ 7.5'		3	Y	4	SBS	16			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Partly Cloudy

TEMP: 80°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
8/29/03	2:15	20'	20'	N/A	N/A	6.3'	BCR
8/29/03	2:30			6.1'	N/A	Wet	ACR
8/29/03	3:50			6.0'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 8/29/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 9

DEPTH IN FEET	SURFACE ELEVATION: 987.02 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0"-6") Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Loose	Glacial Outwash	6	N	1	SBS	17			
2-	(6"-20') Brown Sand, fine grained, poorly graded, (SP), Moist, Loose									
3-			6	N	2	SBS	15			
4-	Light Brown @ 2.5'									
5-	Very Moist and Mottled, Very Loose @ 5'									
6-	Wet @ 6'	▽	3.5	Y	3	SBS	16			
7-										
8-	Loose @ 7.5'		7	Y	4	SBS	15			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Partly Cloudy

TEMP: 80°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
8/29/03	1:15	20'	20'	N/A	N/A	6.6'	BCR
8/29/03	1:30			5.8'	N/A	Wet	ACR
8/29/03	3:45			5.7'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 8/29/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 10

DEPTH IN FEET	SURFACE ELEVATION: 982.12 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0'-1') Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Loose	Glacial Outwash	7	N	1	SBS	14			
2-	(1'-2') Dark Brown Sand, fine grained, poorly graded (SP), Mottled, Moist, Loose									
3-	(2'-20') Brown Sand, fine grained, poorly graded (SP), Moist, Loose		11	N	2	SBS	15			
4-										
5-	Light Brown and Very Moist @ 5'									
6-		▽	9	Y	3	SBS	16			
7-	Wet @ 6.5'									
8-			8	Y	4	SBS	16			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Sunny

TEMP: 75°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
9/2/03	10:30	20'	20'	N/A	N/A	7.0'	BCR
9/2/03	10:45			6.3'	N/A	Wet	ACR
9/2/03	10:55			6.1'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 9/2/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 11

DEPTH IN FEET	SURFACE ELEVATION: 979.83 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0'-1') Dark Brown, Organic Sand, fine grained, poorly graded (OL-SP), Dry, Very Loose	Glacial Outwash	3	N	1	SBS	20			
2-	(1'-20') Brown Sand, fine grained, poorly graded (SP), Dry, Very Loose									
3-	Moist and Mottled, Loose @ 2.5'	▽	8	N	2	SBS	14			
4-										
5-	Wet @ 5'									
6-			6	Y	3	SBS	12			
7-										
8-	Grey @ 7.5'		9	Y	4	SBS	16			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Cloudy

TEMP: 60°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
9/3/03	11:00	20'	20'	N/A	N/A	5.7'	BCR
9/3/03	11:15			3.7'	N/A	3.5'	ACR
9/3/03	11:30			3.0'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 9/3/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 12

DEPTH IN FEET	SURFACE ELEVATION: 980.98 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0"-14") Dark Brown, Organic Sand, fine grained, poorly graded (OL-SP), Dry, Very Loose	Glacial Outwash	4	N	1	SBS	20			
2-	(14"-20') Brown Sand, fine grained, poorly graded (SP), Dry, Very Loose									
3-	Moist and Mottled, Loose @ 2.5'		10	N	2	SBS	14			
4-		▽								
5-	Wet @ 5'									
6-			6	Y	3	SBS	16			
7-										
8-	Grey @ 7.5'		10	Y	4	SBS	18			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Cloudy

TEMP: 65°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
9/3/03	12:45	20'	20'	N/A	N/A	5.7'	BCR
9/3/03	1:00			4.3'	N/A	4.2'	ACR
9/3/03	1:15			4.1'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA

2" OD SBS

F-350 CME 45B

BORING COMPLETED: 9/3/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 13

DEPTH IN FEET	SURFACE ELEVATION: 980.56 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0"-9") Dark Brown, Organic Sand, fine grained, poorly graded (OL-SP), Dry, Very Loose	Glacial Outwash	3	N	1	SBS	18			
2-	(9"-20') Brown Sand, fine grained, poorly graded (SP), Mottled, Moist, Very Loose									
3-	Wet, Loose @ 2.5'		7	Y	2	SBS	12			
4-										
5-										
6-			7	Y	3	SBS	12			
7-										
8-	Grey, Medium Dense @ 7.5'		13	Y	4	SBS	14			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Cloudy

TEMP: 65°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
9/3/03	2:00	20'	20'	N/A	N/A	5.4'	BCR
9/3/03	2:15			2.1'	N/A	Wet	ACR
9/3/03	2:30			2.0'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 9/3/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 15

DEPTH IN FEET	SURFACE ELEVATION: 982.11 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0'-1') Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Very Loose	Glacial Outwash	2	N	1	SBS	16			
2-	(1'-1.5') Dark Brown Sand, fine grained, poorly graded (SP), Mottled, Moist, Very Loose									
3-	(1.5'-20') Brown Sand, fine grained, poorly graded (SP), Mottled, Moist, Very Loose		6	N	2	SBS	15			
4-	Light Brown, Loose @ 2.5'									
5-	Wet @ 5'									
6-			5	Y	3	SBS	15			
7-										
8-			6	Y	4	SBS	14			
9-										
10-										
11-			WT	Y	5	FA				
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA		WEATHER: Sunny		
21-	End of Boring @ 20'. No Refusal.							TEMP: 75°		

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
9/2/03	12:30	20'	20'	N/A	N/A	7.3'	BCR
9/2/03	12:45			4.9'	N/A	4.8'	ACR
9/2/03	12:55			4.6'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 9/2/03

DEVELOPMENT ENGINEERING, PA

SOIL BORING LOG

1296 Hudson Road
St Paul, Mn 55106

PROJECT: 200 Acres Site, Princeton, Mn

LOG OF BORING NO: 14

DEPTH IN FEET	SURFACE ELEVATION: 981.88 DESCRIPTION & CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	L.L./P.L.
1-	(0"-7") Black, Organic Sand, fine grained, poorly graded (OL-SP), Moist, Very Loose	Glacial Outwash	2	N	1	SBS	16			
2-	(7"-20') Brown Sand, fine grained, poorly graded, (SP), Moist, Very Loose									
3-			6	Y	2	SBS	15			
4-	Light Brown and Mottled, Loose @ 2.5'									
5-	Wet @ 4'									
6-	Trace of Organic Fibers @ 5'		6	Y	3	SBS	14			
7-										
8-	Very Loose @ 7.5'		2	Y	4	SBS	16			
9-										
10-	Grey, Loose @ 10'									
11-			9	Y	5	SBS	15			
12-										
13-			WT	Y	6	FA				
14-										
15-										
16-			WT	Y	7	FA				
17-										
18-			WT	Y	8	FA				
19-										
20-			WT	Y	9	FA				
21-	End of Boring @ 20'. No Refusal.									

WEATHER: Clear

TEMP: 75°

WT = weight of truck

WATER LEVEL MEASUREMENTS

DATE	TIME (HRS)	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL	
9/2/03	2:20	20'	20'	N/A	N/A	7.2'	BCR
9/2/03	2:35			4.0'	N/A	Wet	ACR
9/2/03	2:45			3.9'	N/A	Dry	

DRILLING DATA

CREW CHIEF: ELS

METHOD: 3.25 HSA
2" OD SBS
F-350 CME 45B

BORING COMPLETED: 9/2/03

DEVELOPMENT ENGINEERING, PA — SOIL BORING LOG — 1296 Hudson Road, St. Paul, MN 55106

PROJECT: BORING LOG KEY

LOG OF BORING NO: _____

DEPTH IN FEET	SURFACE ELEVATION: / DESCRIPTION AND CLASSIFICATION	GEOLOGY	N	WB	SAMPLE #	SAMPLE TYPE	SAMPLE R	LAB & OTHER TESTS W	DEN	LL / PL
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Soil Classification, using visual-manual and/or laboratory methods, according to the Unified Soil Classification System, or to other system as appropriate

Origin of Soil

Other Data as necessary

Atterberg Limits*

Penetration "N" Value - Number of blows to drive Split-Barrel Sampler one foot

Inplace Density* pcf

Moisture Content* %

Water Bearing
Y = Yes
N = No
▼ = Water Level Symbol

Length of Sample Recovered

Sample Number

Indicates Type of Sample:
SBS = Split-barrel
FA = Flight Auger
HA = Hand Auger
ST = Shelby Tube (thinwall)

* = Lab test on recovered sample

WATER LEVEL MEASUREMENTS

TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING MUD LEVEL	WATER LEVEL

DRILLING DATA

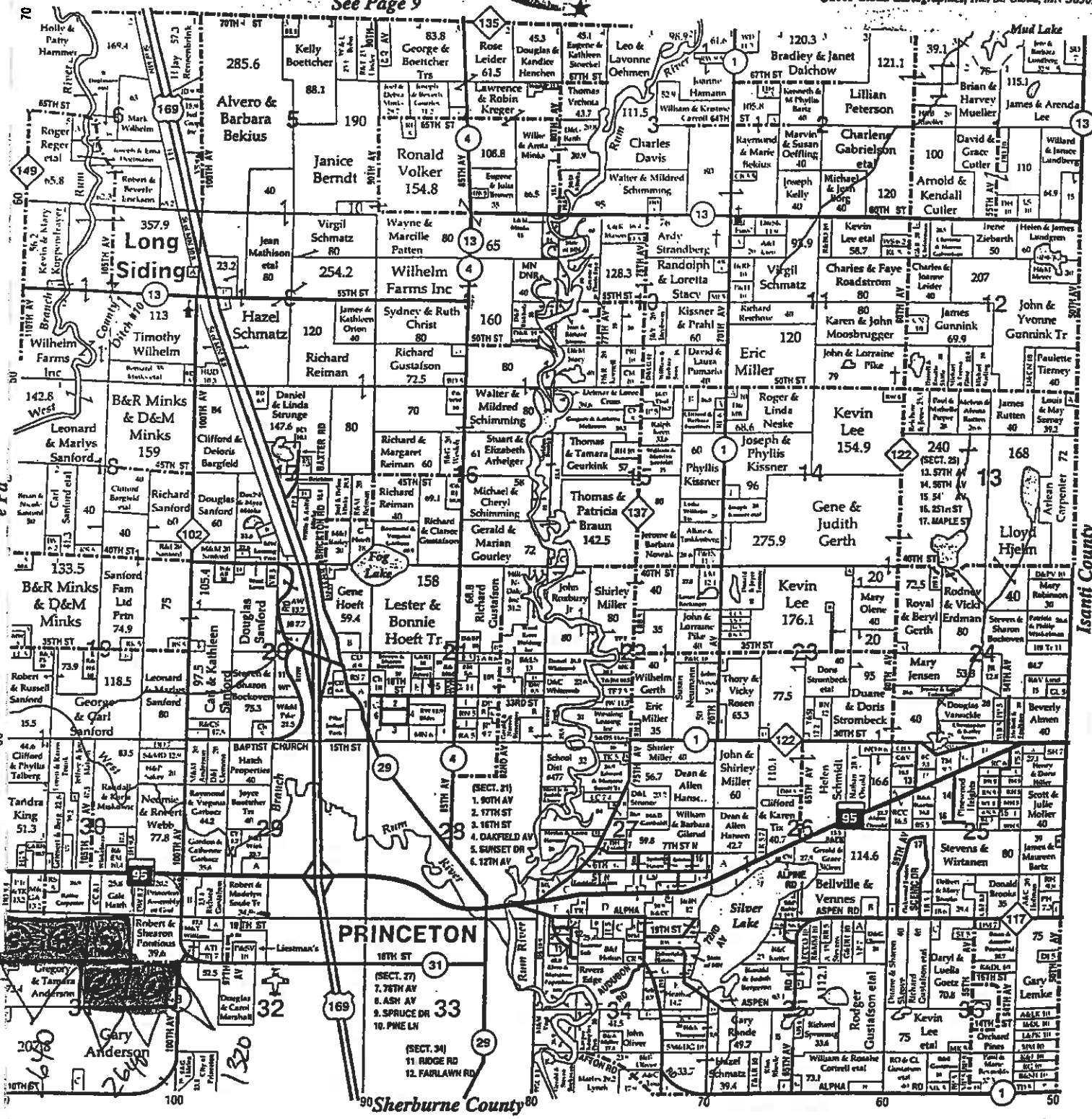
Crew Chief: _____

Method: _____

Princeton

T.36N. - R.26W.

See Page 9



See Page 9

Small Tract Index

	Sec	Letter	Ac
EY & VARNER	2	A	1.3
Y, JOHN	4	A	2
N, WAYNE & MURIEL	4	A	2
EK, ROGER	6	A	4
E, DARLENE	6	B	2.6
DIN, PAUL	7	A	0.8
N, TIMOTHY & CASSANDRA	7	B	0.6
RY, KENNETH & CARRIE	8	B	2.5
ENTRAL ELECTRIC ASSN	8	A	0.6
KOVEN, STEVEN & SHARON	9	A	2.5
ASERA, ANTHONY & KRISTINE	11	A	3
OLKE, RONALD JR	12	A	1.5
, KIMBERLY & LARRY	13	A	0.7
RONALD & KATHERINE	14	A	1.2
PALMER, PAUL & DIANE	14	C	4
NORDSTROM, DOUGLAS	14	B	4
GORANSON, LANCE	15	B	2.5
PAGE, CHRISTOPHER & DANA	15	A	2.5
QUALE, TODD & CINNAMON	15	B	2.5
SMITHERS, BENJAMIN	15	C	4
RATZLAFF, KENNETH	17	A	3.1
FAIRVIEW HOSPITAL & HEALTH CARE	17	B	1.7
CONDERMAN, STUART & LAURIE	17	C	1
LIND, RODNEY & VICKY	17	D	1.3
UNITED POWER ASSN	17	E	0.9
OLENE, GALEN & SHIRLEY	17	F	0.5
MINKS, ERIC & M JACQUELINE	19	A	4.2
HOFMAN, BRENT A	19	B	2.5
ANDREWS, DONALD	20	B	2.5
BAILEY, MICHAEL & JACQUELINE	20	F	0.7
ANDREWS, CHARLES & LINDA	20	B	3.4
SNOW, ALBERT & DEBORAH	20	B	3.9
MADARIS, MICHAEL & RICHELLE	20	C	3.4
ANDREWS, CHARLES & LINDA	20	C	1.7
WALZ, KATHLEEN M	20	F	3.8
SANFORD, CARL & KATHLEEN	20	D	2
FRAUENDIENST, PAMELA & RICHARD	20	E	2.5
LUKKEN, KAREN L	20	A	1.7
SCHUMACHER, JOHN & RITA	20	A	1.1
GREENWOOD, SAMUEL T	20	A	0.4
KINNEY, RONALD & JACOULYN	20	A	2.3
KOK, DOUGLAS & TAMMY	20	A	0.4
ANDERSON, HARVEY & NORMA	20	A	0.8
DEWITT, CRAIG & MARY	20	A	0.8
STANHOPE & TAINTER	21	A	1.3
REED, RANDY D	21	B	1.1
ALLEY, ROBERT W	21	C	2
WHITCOMB, DANIEL S	21	D	3.4
ORSBURNE, DAVID & KAREN	21	H	0.7
GUNNINK, ALVIN & MARILYN	21	H	1
WERSAL, DEBRA J	21	E	1.1
SORENSON, TERRY & WENDY	21	E	4.6
WILLS, PATRICIA	21	F	3.9
APPLEGATE, ALLEN & RAMONA	21	F	1
BREDEMUS, TIMOTHY J	21	F	1
FETCHENHIER, RICHARD	21	F	3.9
GASSETT, ANNELLA R	21	F	1
GUIMONT, MICHAEL & ALICE	21	F	0.8
R W PROPERTIES LLC	21	F	1.4

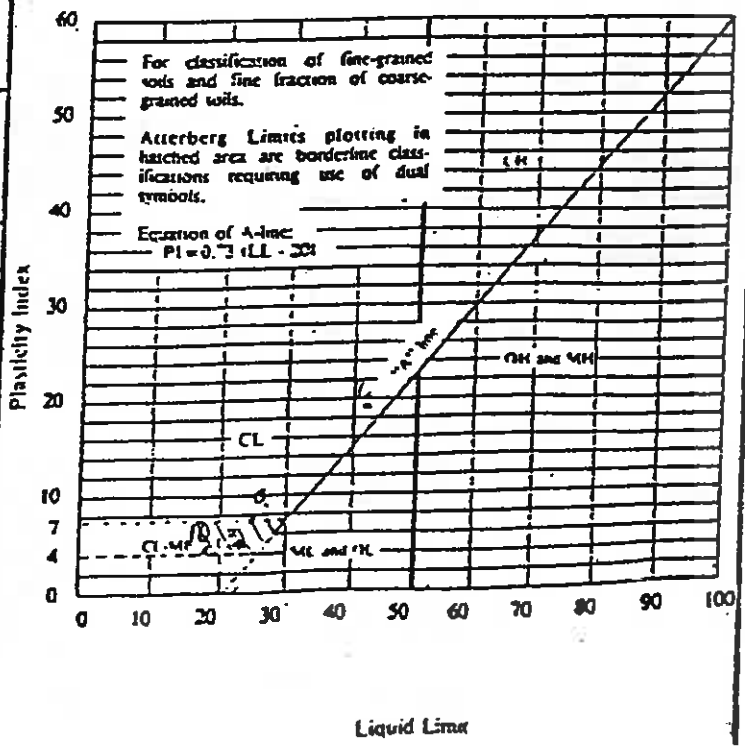
UNIFIED SOIL CLASSIFICATION

Major Divisions			Group symbols	Typical names	Laboratory classification criteria
Coarse grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$ between 1 and 3
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW
		Gravels with fines (Appreciable amount of fines)	GM d / u	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$ between 1 and 3
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM d / u	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above "A" line with P.I. greater than 7
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL	Organic silts and organic silty clays of low plasticity	
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
			CH	Inorganic clays of high plasticity, fat clays	
			OH	Organic clays of medium to high plasticity, organic silts	
Highly organic soils			Pt	Peat and other highly organic	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:
Less than 5 per cent ..... GW, GP, SW, SP
More than 12 per cent ..... GM, GC, SM, SC
5 to 12 per cent ..... *Borderline* cases requiring dual symbols

Above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols

Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols



BITUMINOUS PAVEMENT SUBGRADE PREPARATION AND DESIGN

GENERAL

Bituminous pavements are considered layered "flexible" systems. Dynamic wheel loads transmit high local stresses through the bituminous/base onto the subgrade. Because of this, the upper portion of the subgrade requires height strength/stability to reduce deflection and fatigue of the bituminous/base system. The wheel load intensity dissipates through the subgrade such that the high level of soil stability is usually not needed below about 2' to 4' (depending on the anticipated traffic and underlying soil conditions). This is the primary reason for specifying a higher level of compaction within the upper subgrade zone versus the lower portion. Moderate compaction is usually desired below the upper critical zone, primarily to avoid settlements/sags of the roadway. However, if the soils present below the upper 3' subgrade zone are unstable, attempts to properly compact the upper 3' zone to the 100% level may be difficult or not possible. Therefore, control of moisture just below the 3' level may be needed to provide a non-yielding base upon which to compact the upper subgrade soils.

Long-term pavement performance is dependent on the soil subgrade drainage and frost characteristic. Poor to moderate draining soils tend to be susceptible to frost heave and subsequent weakening upon thaw. This condition can result in irregular frost movements and "popouts," as well as an accelerated softening of the subgrade. Frost problems become more pronounced when the subgrade is layered with soils of varying permeability. In this situation, the free-draining soils provide a pathway and reservoir for water infiltration which exaggerates the movements. The placement of a well drained sand subbase layer as the top of subgrade can minimize trapped water, smooth frost movements and significantly reduce subgrade softening. In wet, layered and/or poor drainage situations, the long-term performance gain should be significant. If a sand subbase is placed, we recommend it be a "Select granular Borrow" which meets Mn/DOT specification 3149.2B.

PREPARATION

Subgrade preparation should include stripping surficial vegetation and organic soils. Where the exposed soils are within the upper "critical" subgrade zone (generally 2 ½' deep for "auto only" areas and 3' deep for "heavy duty" areas), they should be evaluated for stability. Excavation equipment may make such areas obvious due to deflection and rutting patterns. Final evaluation of soils within the critical subgrade zone should be conducted by test rolling with heavy rubber-tired construction equipment, such as a loaded dump truck. Soils which rut or deflect 1" or more under the test roll should be corrected by either subcutting and replacement; or by scarification, drying, and recompaction. Reworked soils and new fill should be compacted per the "Specified Density Method" outlined in Mn/DOT Specification 2105.3F1.

Subgrade preparation scheduling can be an important consideration. Fall and Spring seasons usually have unfavorable weather for soil drying. Stabilizing non-sand subgrades during these seasons may be difficult, and attempts often result in compromising the pavement quality. Where construction scheduling requires subgrade preparation during these times, the use of a sand subbase becomes even more beneficial for constructability reasons.

SUBGRADE DRAINAGE

If a sand subbase layer is used, it should be provided with a means of subsurface drainage to prevent water build-up. This can be in the form of draintile lines which tap into storm sewer systems, or outlets into ditches. Where sand subbase layers include sufficient sloping, and water can migrate to lower areas, draintile lines can be limited to finger drains at the catch basins. Even if a sand layer is not placed, strategically placed draintile lines can aid in improving pavement performance. This would be most important in areas where adjacent non-paved areas slope towards the pavement. Perimeter edge drains can aid in intercepting water which may infiltrate below the pavement.

BOUNDARY AND T

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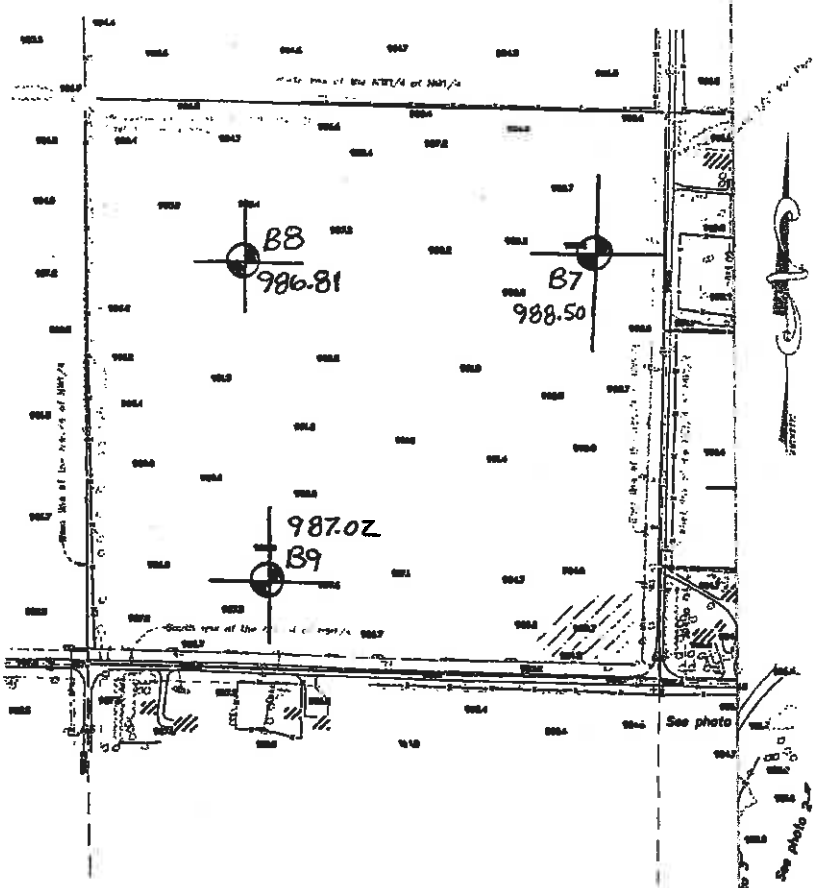

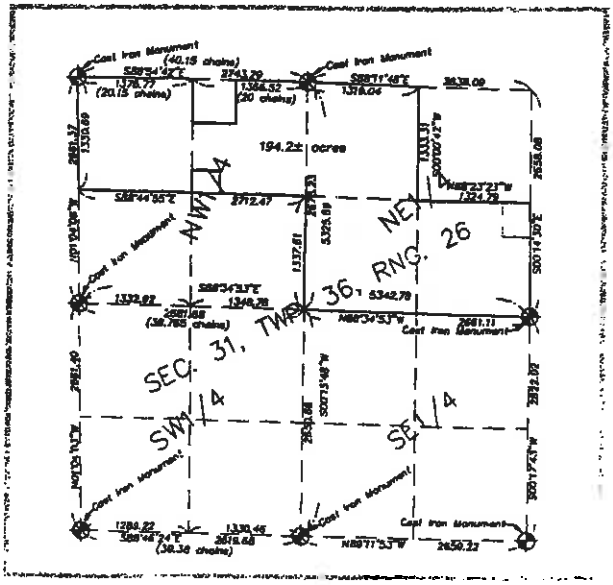

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